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Materiel Test Procedure 7-4-006
U. S. Army Arctic Test Center

U. S. ARMY TEST AND EVALUATION COMMAND
ENVIRONMENTAL TEST PROCEDURE

ARCTIC ENVIRONMENTAL TEST OF ROTARY WING AIRCRAFT

1. OBJECTIVE

The objective of the procedures outlined in this MTP is to provide a means of evaluating the performance, safety, and human factors engineering characteristics of rotary wing aircraft under arctic winter conditions.

2. BACKGROUND

Arctic environmental testing of rotary wing aircraft is conducted to determine if the aircraft performs satisfactorily in an arctic winter environment. These tests are intended to supplement engineering and service tests performed in the temperate zone.

Testing under arctic winter conditions is usually not conducted until the aircraft has been evaluated under simulated climatic extremes (environmental hangar). Environmental hangar testing is used to develop starting procedures and to check the operation of all components down to -65°F. Testing in natural climatic environments is used to substantiate or supplement data obtained in the environmental hangar tests.

Results of arctic testing produce data required for type classification and information essential for procurement or other logistical decisions.

Since specific criteria for conducting arctic tests is frequently not provided or is limited in scope, it is often necessary to compare the test helicopter with a similar type helicopter in the inventory. The resulting data is then presented as a performance comparison rather than a qualitative analysis.

3. REQUIRED EQUIPMENT

- a. Appropriate arctic winter uniform.
- b. Vehicles (Tactical vehicles and warehouse tractors).
- c. Airfield and support facilities.
- d. Comparison aircraft.
- e. Ground support equipment as required.
- f. Aircraft repair parts, adequate for duration of test period.
- g. All general and special tools and ancillary items required.
- h. Aircraft winterization kit.
- i. Aircraft heater, portable duct type.
- j. Refueling equipment as appropriate.
- k. Auxiliary power unit, model E.
- l. Aircraft skis if applicable.
- m. Aircraft maintenance package.
- n. Meteorological support facility.

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- o. Aircraft engine test equipment as required.
- p. Still and motion picture cameras (black and white or color).

4.

REFERENCES

- A. AR 70-10, Army Materiel Testing.
- B. AR 70-38, Research, Development, Test and Evaluation of Materiel for Extreme Climatic Conditions.
- C. AR 705-24, Management of Test and Test Support Aircraft.
- D. AR 705-25, Reliability Program for Materiel and Equipment.
- E. AMCR 385-12, Verification of Safety of Materiel From Development Through Testing, Production and Supply to Disposition.
- F. USATECOM Regulation 385-6, Verification of Materiel During Testing.
- G. USATECOM Regulation 750-15, Maintenance of Supplies and Equipment.
- H. TB 55-6650-300-15, Spectrometric Oil Analysis.
- I. TM 55, Appropriate series pertaining to Test Aircraft.
- J. MTP 7-1-001, Testing Aviation Equipment.
- K. MTP 7-3-020, Aircraft Flight Test (Fixed or Rotary Wing).
- L. MTP 7-3-021, Aircraft, Suitability for Army Use.
- M. MTP 7-3-025, Aircraft, Suitability as a Troop Transport.
- N. MTP 7-3-027, Aircraft, Suitability for Transport of Litter Patients.
- O. MTP 7-3-028, Aircraft, Suitability for Transporting Supplies and Equipment.
- P. MTP 7-3-501, Personnel Training.
- Q. MTP 7-3-505, Transportability.
- R. MTP 7-3-509, Compatibility with Related Equipment.
- S. MTP 7-3-515, Air Transport, Internal (Suitability of Equipment for).
- T. MTP 10-4-500, Arctic Environmental Testing, Preoperational Inspection, Physical Characteristics, Human Factors Safety and Maintenance Evaluation.

5.

SCOPE

5.1

SUMMARY

The procedures outlined in this MTP are designed to determine and evaluate the performance characteristics of rotary wing aircraft under arctic winter environmental conditions.

- a. Preoperational Inspection and Physical Characteristics - This test provides for an inspection of the test item to:

- 1) Identify damage received during shipping and handling.
- 2) Determine its physical conditions.
- 3) Determine if the test item dimensions, weight and characteristics conform to applicable criteria.
- 4) Locate any defects.

- b. Operational Suitability - The objective of this subtest is to

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determine the cold starting characteristics of the test helicopter engines.

c. Suitability of aircraft Heating and Defrosting System - The objective of this subtest is to determine the warmup characteristics of the crew and passenger compartments of the test helicopter.

d. Functional, Flight and Performance Characteristics - The objective of this subtest is to determine the test helicopter's ability to perform its intended mission and to determine its flight and performance characteristics under arctic winter environmental conditions.

e. Compatibility with Related Equipment - The objective of this subtest is to determine the compatibility of the test helicopter with related ground support equipment.

f. Human Factors Engineering - The objective of this subtest is to determine the human factors aspects of the test helicopter.

g. Maintenance Evaluation - The objective of this subtest is to determine if the test helicopter meets maintenance and maintainability requirements as defined by QMR, SDR, TC, MC, or other established criteria under arctic winter environmental conditions.

5.2 LIMITATIONS

The procedures described in this MTP are general in nature and limited to the testing of rotary wing aircraft only.

Tear down inspections of major components are not ordinarily performed prior to or after testing. If tear down inspections are required, they must be specifically directed by the developer in the case of Category II tests or by the U. S. Army Test and Evaluation Command in the case of Category I tests.

Those procedures that duplicate testing that has been conducted at other facilities and are not peculiar to an arctic winter environment will not normally be conducted.

6. PROCEDURES

6.1 PREPARATION FOR TEST

a. Since arctic winter environmental tests are normally scheduled from October through March (6 months), ensure that the test and comparison aircraft are delivered to the Arctic Test Center prior to 1 October and 30 days before start of test.

b. TDY personnel shall be used to augment assigned personnel and shall be trained to the degree that they are as proficient on the individual equipment as the troops who will use the item.

c. Ensure that all test personnel are familiar with the required technical and operational characteristics of the item under test, such as stipulated in Qualitative Materiel Requirements (QMR), Small Development requirements (SDR), and Technical Characteristics (TC), and record this criteria in the test plan.

d. Review all instructional material issued with the test item by the manufacturer, contractor, or government, as well as reports of previous tests

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conducted on the same type of equipment, and familiarize all test personnel with available reference.

e. Record the grade, MOS, background, and training of all test personnel and ensure that all personnel receive new equipment training (NET) as referenced in 4 P.

f. Record the following information:

- 1) Nomenclature, serial number(s), and manufacturer's name of the test items.
- 2) Nomenclature, serial number(s), accuracy tolerances, calibration requirements, and last date calibrated of the test equipment selected for the tests.

g. Select test equipment ideally having an accuracy 10 times greater than that of the function to be measured.

h. Prepare record forms for systematic entry of data, chronology of test, and analysis in final evaluation.

i. Prepare adequate safety precautions to provide safety for personnel and equipment, and ensure that all safety releases are obtained and safety SOP's are observed throughout the test.

j. Outfit all test personnel in appropriate arctic winter uniform as described in MTP 10-4-500, with the exception that the winter weight flight jacket (NB-2 or NB-3), will be used as the outer garment. Leather flying gloves with wool inserts will be substituted for the arctic mitten set.

k. Ensure that when not in use, all test and comparison aircraft are stored and maintained in an unsheltered area and exposed to ambient air temperature and prevailing weather conditions.

l. Record the prevailing meteorological conditions during the storage phase, as well as test conduct, to include:

- 1) Temperature.
- 2) Humidity, relative or absolute.
- 3) Temperature gradient.
- 4) Atmospheric pressure.
- 5) Precipitation.
- 6) Solar radiation.
- 7) Wind speed and direction.
- 8) Frequency of readings.
- 9) Source of data.

6.2 TEST CONDUCT

- NOTE: 1. During all testing the test helicopter will be operated in as wide a range of temperatures as available. Attempts will be made to accumulate data and compare performance in ambient air temperatures between 0° F and -25° F to the lowest ambient air temperature available. The length of cold soak periods and ambient air temperatures during cold soak periods will be recorded during each subtest as appropriate.
2. When applicable, test operations shall be conducted on a

combined basis in order to avoid duplication.

6.2.1 Preoperational Inspection and Physical Characteristics

Upon receipt, carefully inspect the test and comparison helicopter and their shipping and/or packaging containers for completeness, damage and general conditions in accordance with applicable sections of MTP 10-4-500.

NOTE: Physical characteristics will be determined only to the extent necessary to determine compliance with those characteristics specified in QMR's, SDR's, TC's, or MC's. If the aircraft is a standard item for which there is a record of physical characteristic verifications at other test installations, it is not necessary to repeat the measurements.

6.2.2 Operational Suitability

6.2.2.1 Cold Starting

a. Cold soak the test helicopter until the component temperatures (engine oil, fuel and battery electrolyte), approximate those of the existing ambient air temperature.

b. Utilizing the procedures outlined in the operator's manual or as provided by the developer perform cold start attempts utilizing the following:

- 1) Test helicopter electrical system (cold-soak battery).
- 2) Test helicopter electrical system (warm battery).
- 3) Test helicopter electrical system (warm battery removed from storage with preheat increments of 15 minutes).
- 4) External auxiliary power unit.
- 5) External auxiliary power unit after preheat period increments of 15 minutes.

c. Determine and record the cold starting characteristics of the engines.

NOTE: If the procedures outlined in operator's manual or as provided by the developer fails to produce a start, further attempts will be made as suggested and/or approved by the manufacturer's technical representative and project manager.

d. After engine(s) start has been achieved operate the engine(s) until operating conditions are attained and determine the warmup characteristics of the engine(s).

NOTE: Operating conditions will vary greatly dependent on the type engine installed in the test helicopter.

e. When operating conditions are obtained, perform an engine(s) runup in accordance with instructions contained in the operator's manual and

determine the runup characteristics of the engine(s).

f. Record the following:

- 1) Starting procedure sequence.
- 2) Deviation from starting procedures as outlined in operator's manual, if applicable.
- 3) Length of the cold-soak period.
- 4) Ambient temperature range during the cold-soak period.
- 5) Ambient temperature at the time of attempted start.
- 6) Temperature of fuel, oil, hydraulic fluid, and battery electrolyte, at time of engine(s) start.
- 7) Preheat time, if applicable.
- 8) Elapsed time from engine(s) start until operating conditions are attained.
- 9) Engine(s) instrument indication during starting, warmup and operation, as applicable.

6.2.3 Suitability of Helicopter Heating and Defrosting Systems

a. Conduct this subtest concurrently with the operational tests of this MTP.

b. A minimum of five tests shall be conducted in each temperature range 0°F to -25°F and -25°F to the lowest available temperature.

c. Operate the heater and defrosting system in accordance with instructions outlined in the operator's manual.

d. Record the temperature as follows:

- 1) Prior to heater operation.
- 2) Five minute intervals after heater start for the first 30 minutes of operation, one of which will be taken during ground operation.
- 3) Every 30 minutes thereafter until completion of the flight.

e. The heater shall be operated on high output with all fresh air ventilators closed to insure uniformity of test results.

f. Ensure that the windshields defrost settings are at the minimum required to maintain the windshields free of frost.

g. Measure and record the carbon monoxide concentration in the crew and passenger compartments.

NOTE: Step g. above shall be conducted once during ground operation and in flight for each temperature range as specified.

h. Record the following data:

- 1) Ambient air temperature at the test site.
- 2) Air temperature in the crew and passenger compartment at the foot, hand and face levels at intervals specified in step d. above.
- 3) Ambient air temperature at flight altitude from the aircraft free air temperature gauge at intervals specified in step

- d. above.
- 4) Defrost setting required to maintain the windshield free of frost during ground and flight operations.

NOTE: Still photographs shall be utilized to supplement other recorded data as required.

6.2.4

Functional, Flight and Performance Characteristics

- NOTE: 1. Each mission so specified shall be conducted in each temperature range as stated in paragraph 6.2 using passengers as required, actual or simulated cargo, simulated litter patients, and other devices as appropriate and in accordance with applicable sections of MTP's 7-3-020, 7-3-021, 7-3-025, 7-3-027, 7-3-028, and 7-3-515.
2. Performance testing shall include flight planning as required, preflight inspection of the test helicopter, loading of passengers, cargo or equipment if appropriate; flight portion; off loading and post flight inspection.

- a. When appropriate, considering passenger and cargo carrying requirements, the test helicopter shall be operated at maximum gross takeoff and landing weights on at least 10 percent of the missions.
- b. At least 50 percent of the flying time allocated to the test shall be devoted to determination of functional suitability.

NOTE: During operation of rotary aircraft in an arctic winter environment the only predictable ambient temperature encountered is at the surface; therefore, the surface ambient temperature will be recorded as the official operating temperature for conduct of the mission. The ambient temperature at cruising and/or operational altitude will be recorded for information only in this sub-test.

- c. Perform flight maneuvers as required by the U. S. Army Test and Evaluation Command or the developer to determine specific flight and performance characteristics.

- d. Record the following data:

- 1) Nature of mission.
- 2) Features of the test helicopter that enhance or detract from specific mission performance.
- 3) Ambient outside air temperature at the surface during engine start and engine shutdown.
- 4) Type of flight and/or performance characteristics being evaluated.
- 5) Test personnel evaluation of the test helicopter's ability to perform the flight maneuver.

NOTE: Motion pictures shall be taken to support data as required.

6.2.5 Compatibility with Related Equipment

- a. Conduct this subtest concurrently with the operational tests of this MTP and applicable sections of MTP 7-3-505 and 7-3-509.
- b. Tow the helicopter using standard gasoline driven warehouse tractor and army tactical vehicles as appropriate.
- c. Conduct a fueling operation using the army standard fuel truck or the dispensing pump, hand driven, as appropriate.
- d. Preheat the helicopter as required in paragraph 6.2.2 during cold start attempts using the Heater, Duct-type, Portable, with a rating of 400,000 BTU.
- e. Utilize the Generator Set, Gasoline Engine, Model E, Auxiliary Power Unit during engine cold start attempts.
- f. Record the following data:
 - 1) Nature of ground handling or ground support operation.
 - 2) Surface condition or snow depth, if applicable.
 - 3) Ambient air temperature.
 - 4) Test personnel evaluation of compatibility of ground support equipment.
 - 5) Difficulties encountered or failure of any item of ground support equipment to accomplish its design function.

NOTE: Still photographs and motion picture coverage shall be utilized to supplement recorded data.

6.2.6 Human Factors Engineering and Safety

- a. Conduct all Human Factors Engineering and Safety Tests in accordance with the applicable sections of MTP 10-4-500.
- b. Conduct these tests concurrently with the operational tests described in this MTP.
- c. All test personnel shall complete the appropriate questionnaire, Appendix A.

6.2.7 Maintenance Evaluation

- a. Conduct all maintenance evaluation tests (maintenance and reliability) in accordance with the applicable sections of MTP 10-4-500.
- b. Conduct these tests concurrently with the operational tests described in this MTP and include the following:
 - 1) Record failure of any system, sub-system or component thereof of the test aircraft and the time of failure expressed in total cumulative flying hours on the airframe.
 - 2) Engine oil samples shall be taken upon receipt of the helicopter and at intervals specified in TB 55-6650-300-15 or by U. S. Army Aviation Materiel Command. Record the following:
 - a) Helicopter time (hours) when sample is taken.
 - b) Report of contamination, if any.

- c) Action taken, if required.
- 3) Fill the fuel and oil reservoirs to specified level prior to each flight. Record the following:
 - a) Total flying hours during test conduct.
 - b) Total fuel consumed in gallons during test conduct.
 - c) Total engine oil consumed, excluding oil changes, during test conduct.

6.3 TEST DATA

All test data to be recorded shall be as specified in the individual subtests of this MTP.

6.4 DATA REDUCTION AND PRESENTATION

Processing of raw test data shall, in general, consist of organizing marking for identification and correlation, and grouping the test data according to test title.

Specific instructions for the reduction and presentation of individual test data are outlined in the succeeding paragraphs.

6.4.1 Preoperational Inspection and Physical Characteristics

Preoperational inspection and physical characteristics data shall be reduced and presented in accordance with MTP 10-4-500.

6.4.2 Operational Suitability

Examine the recorded data and evaluate the suitability of the test item in arctic environment by determining the following:

- a. If the test item has characteristics that are equal to or surpass those of the comparison items.
- b. If the test items meet or exceed the appropriate specifications contained in QMR's, TC's, SDR's, and MC's.

Data recorded in paragraph 6.2.2, Operational Suitability, shall be reviewed and the ease of operation shall be evaluated.

Prepare a comprehensive report on the findings of the above evaluations.

6.4.3 Suitability of Helicopter Heating and Defrosting Systems

Examine the recorded data and evaluate the suitability of the heating and defrosting systems in the arctic environment by comparison with previous accepted items of a like nature.

6.4.4 Functional, Flight and Performance Characteristics

The operation of the test helicopter under test in extreme arctic winter conditions shall be determined by comparison with previously accepted aircraft of like nature and specifications. The damage to the test helicopter attributed to arctic environmental effects shall be compared to applicable specifications contained in QMR, SDR, TC and MC.

6.4.5 Compatibility with Related Equipment

The compatibility of the test helicopter with related equipment shall be determined by the following:

- a. If the test helicopter has characteristics that are equal to or surpass those of the comparison aircraft.
- b. If the test helicopter meets or exceeds the appropriate specifications contained in QMR's, TC's, SDR's and MC's.

Data recorded in paragraph 6.2.5, Compatibility with Related Equipment shall be reviewed and the ease of operation shall be evaluated.

6.4.6 Human Factors Evaluation and Safety

Human Factors Evaluation and Safety data shall be reduced and presented in accordance with MTP 10-4-500.

Evaluate recorded data and relate results of evaluation to how the test equipment may be improved.

6.4.7 Maintenance Evaluation

Maintenance Evaluation data shall be reduced and presented in accordance with MTP 10-4-500.

APPENDIX A

HUMAN FACTORS ENGINEERING CHECKLISTS

1. CREWMEMBER'S (PILOT AND COPILOT)

A. Complete the following checklist after each flight on difficulties in performing any item of the following checklist areas. If a difficulty is encountered, record the area and item number and explain in the space provided.

	<u>YES</u>	<u>NO</u>
(1) Before exterior check	—	—
(2) Exterior check	—	—
(3) Interior check	—	—
(4) Before starting engines	—	—
(5) Starting engines	—	—
(6) Before taxiing	—	—
(7) Taxiing	—	—
(8) Engine runup	—	—
(9) Before takeoff	—	—
(10) Line up	—	—
(11) After takeoff-climb	—	—
(12) Before landing	—	—
(13) Landing check	—	—

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	<u>YES</u>	<u>NO</u>
(14) Go around	—	—
(15) After landing	—	—
(16) Engine shutdown	—	—
(17) Before leaving aircraft	—	—

Area _____

Item No(s) _____

Explain _____

B. Were any objectionable heat or cold conditions noted in the pilot's compartment?

Explain _____ YES NO

C. Did any features of the pilot's or copilot's chair cause discomfort?

Explain _____ YES NO

D. Was cockpit and instrument lighting adequate to perform cockpit checks and for operation of the test helicopter?

Explain _____ YES NO

E. Were any difficulties encountered entering and leaving the helicopter by both normal and emergency entrances and exits?

Explain _____ YES NO

F. Were any safety hazards encountered during operation of the test helicopter?

Explain _____ YES NO

G. If any human factors engineering difficulty not covered by a checklist item was encountered in operating the test helicopter, explain the difficulties in the space provided.

Explain _____

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2. CREWMEMBER'S (CREWCHIEF)

A. Record any human factors engineering difficulty encountered in maintaining, servicing, loading, off-loading, entering and exiting the test helicopter by answering the following questions at the completion of each flight. Explain any difficulty in detail in the space provided.

B. Were any difficulties encountered in performing the following items:

(1) Preventive Maintenance Daily (PMD), Intermediate (PMI)
and Periodic (PMP) Inspections. YES NO

— —

(2) Unscheduled Organizational Maintenance. YES NO

— —

Explain _____

C. Were any difficulties encountered in servicing the test helicopter?

Explain _____ YES NO

D. Were any difficulties encountered in loading or off-loading cargo or litter patients?

Explain _____ YES NO

E. Were any difficulties encountered in entering and exiting the test helicopter by both normal and emergency entrance and exits?

Explain _____ YES NO

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F. Were any safety hazards encountered in maintaining or servicing the test helicopter?

Explain _____ YES NO

G. Were any objectionable heat or cold conditions encountered in the passenger compartment?

Explain _____ YES NO

H. Did any feature of the passenger seat cause discomfort?

Explain _____ YES NO

I. If any other human factors engineering difficulties not covered in the checklist were encountered, explain in the space provided.

Explain _____

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3. PASSENGERS

A. Did you encounter any difficulty entering or exiting the helicopter?

Explain _____ YES NO

B. Did you have any difficulty stowing hand carried gear under the passenger seats?

Explain _____ YES NO

C. Were there any objectionable heat or cold conditions in the passenger compartment?

Explain _____ YES NO

D. Did any feature of the passenger seat cause discomfort?

Explain _____ YES NO

E. If any other human factors engineering difficulties not covered in the checklist were encountered, explain in the space provided.

Explain _____

4. LITTER PATIENTS

A. Did you note any objectionable heat or cold conditions in the passenger compartment?

Explain _____ YES NO

B. Did any feature of the test helicopter cause discomfort while you were occupying the litter?

Explain _____ YES NO

C. If any human factors engineering difficulty not covered in this checklist were encountered, explain in the space provided.

Explain _____

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5. MEDICAL ATTENDANTS

A. Did you encounter any difficulty entering or exiting the test helicopter?

Explain _____	<u>YES</u>	<u>NO</u>
_____	---	---

B. Did you encounter any difficulty stowing hand carried medical gear?

Explain _____	<u>YES</u>	<u>NO</u>
_____	---	---

C. Did you encounter any difficulty attending to the litter patients?

Explain _____	<u>YES</u>	<u>NO</u>
_____	---	---

D. Did you note any objectionable heat or cold conditions in the test helicopter?

Explain _____	<u>YES</u>	<u>NO</u>
_____	---	---

E. Did any feature of the passenger seat cause discomfort?

Explain _____	<u>YES</u>	<u>NO</u>
_____	---	---

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F. If any other human factors engineering difficulty not covered in this checklist was encountered, explain in the space provided.

Explain _____

6. MAINTENANCE PERSONNEL

A. Maintenance personnel other than the crewchief will complete this checklist upon completion of scheduled intermediate and periodic preventive maintenance inspections, and after completion of unscheduled maintenance performed at the direct support (DS) level.

B. Were any difficulties encountered in performing maintenance on the test helicopter during the following:

	<u>YES</u>	<u>NO</u>
(1) Preventive Maintenance Intermediate Inspection (PMI)	—	—
(2) Preventive Maintenance Periodic Inspection (PMP)	—	—
(3) Unscheduled Direct Support (DS) Inspection	—	—

Explain _____

C. Were any safety hazards encountered while performing maintenance on the test helicopter?

Explain _____

D. If any other human factors engineering difficulties not covered by this checklist were encountered, explain in the space provided.

Explain _____

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13. ABSTRACT This Environmental Test Procedure describes test methods and techniques for evaluating the performance and characteristics of Rotary Wing Aircraft under Arctic winter conditions. Evaluation is related to criteria established by Qualitative Materiel Requirements (QMR), Small Development Requirements (SDR), Technical Characteristics (TC), and other design requirements or specifications. Where criteria is limited in scope, or lacking, comparison testing with a similar type aircraft in the inventory may be necessary. ()			

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